CLAIMS

1. A rotational angle detecting device, comprising:

a rotor having targets disposed on the circumferential surface of said rotor, said targets being made of magnetic material and inclined with respect to an axial direction of said rotor; and

plural magnetoresistance effect elements for detecting the position where magnetic change occurs in an axial direction of said rotor; wherein

a displacement angle of said rotor from said plural magnetoresistance effect elements is detected on the basis of the positions detected by said plural magnetoresistance effect elements.

2. A torque detecting device for detecting torque applied on an input shaft in accordance with a torsional angle generated in a connecting shaft for connecting said input shaft and an output shaft, comprising:

rotational angle detecting devices attached to each of said input and said output shaft, respectively, said rotational angle detecting devices comprising:

a rotor having targets disposed on the circumferential surface of said rotor, said targets being made of magnetic material and inclined with respect to an axial direction of said rotor; and

plural magnetoresistance effect elements for

detecting the position where magnetic change occurs in an axial direction of said rotor; wherein

a displacement angle of said rotor from said plural magnetoresistance effect elements is detected on the basis of the positions detected by said plural magnetoresistance effect elements; and

a displacement angle difference detector for detecting the difference between the rotational angles detected by said rotational angle detecting devices; wherein

the difference in the rotational angle detected by said displacement angle difference detector is made to be the torsional angle.

3. A torque detecting device for detecting torque applied on an input shaft in accordance with a torsional angle generated in a connecting shaft for connecting said input shaft and an output shaft, comprising:

rotational angle detecting devices attached to each of said input shaft and said output shaft, respectively, said rotational angle detecting devices comprising:

a rotor having targets disposed on the circumferential surface of said rotor, said targets being made of magnetic material and inclined with respect to an axial direction of said rotor; and

plural magnetoresistance effect elements for

detecting the position where magnetic change occurs in an axial direction of said rotor; wherein

a displacement angle of said rotor from said plural magnetoresistance effect elements is detected on the basis of the positions detected by said plural magnetoresistance effect elements; and

two first calculators for calculating the opposite-phase difference between detection signals detected by said rotational angle detecting devices; and

a second calculator for calculating the difference between the differences calculated by said two first calculator; wherein

the difference detected by said second calculator is made to be the torsional angle.

4. A steering apparatus, comprising:

an input shaft connected to a steering wheel;

an electric motor for assisting steering which is driven and controlled in accordance with steering torque applied on said steering wheel; and

an output shaft interlocked to said electric motor; said steering apparatus characterized by comprising:

a torque detecting device for detecting torque applied on an input shaft in accordance with a torsional angle generated in a connecting shaft for connecting said input shaft and an output shaft, comprising:

rotational angle detecting devices attached to each of said input shaft and said output shaft, respectively, said rotational angle detecting devices comprising:

a rotor having targets disposed on the circumferential surface of said rotor, said targets being made of magnetic material and inclined with respect to an axial direction of said rotor; and

plural magnetoresistance effect elements for detecting the position where magnetic change occurs in an axial direction of said rotor; wherein

a displacement angle of said rotor from said plural magnetoresistance effect elements is detected on the basis of the positions detected by said plural magnetoresistance effect elements; and

a displacement angle difference detector for detecting the difference between the rotational angles detected by said rotational angle detecting devices; wherein

the difference in the rotational angle detected by said displacement angle difference detector is made to be the torsional angle; wherein

a rotational angle detecting device included in said torque detecting device detects the rotational angle of said steering wheel.

5. A steering apparatus, comprising:

an input shaft connected to a steering wheel;

an electric motor for assisting steering which is driven and controlled in accordance with steering torque applied on said steering wheel; and

an output shaft interlocked to said electric motor; said steering apparatus characterized by comprising:

a torque detecting device for detecting torque applied on an input shaft in accordance with a torsional angle generated in a connecting shaft for connecting said input shaft and an output shaft, comprising:

rotational angle detecting devices attached to each of said input shaft and said output shaft, respectively, said rotational angle detecting devices comprising:

a rotor having targets disposed on the circumferential surface of said rotor, said targets being made of magnetic material and inclined with respect to an axial direction of said rotor; and

plural magnetoresistance effect elements for detecting the position where magnetic change occurs in an axial direction of said rotor; wherein

a displacement angle of said rotor from said plural magnetoresistance effect elements is detected on the basis of the positions detected by said plural magnetoresistance effect elements; and

two first calculators for calculating the opposite-phase difference between detection signals detected by said rotational angle detecting devices; and

a second calculator for calculating the difference between the differences calculated by said two first calculator; wherein

the difference detected by said second calculator is made to be the torsional angle; wherein

a rotational angle detecting device included in said torque detecting device detects the rotational angle of said steering wheel.

6. A torque detecting device, comprising:

an input shaft and an output shaft each having targets disposed on the circumferential surfaces of said input shaft and said output shaft, said targets being made of magnetic material and inclined with respect to an axial direction of said input shaft;

a connecting shaft for connecting said input shaft and said output shaft;

first magnetic sensor and second magnetic sensor for detecting the positions where magnetic change occurs on the circumferential surfaces of said input shaft and said output shaft;

third magnetic sensor and fourth magnetic sensor for detecting the positions where magnetic change occur in said axial direction which are distant from said positions detected by said first magnetic

sensor and said second magnetic sensor for a predetermined distance in said circumferential direction and/or said axial direction;

a first judging unit for judging whether or not said positions detected by said first to fourth magnetic sensors are included in a first range;

a selector for selecting the position for detecting a torsional angle of said connecting shaft for each of said input shaft and said output shaft in accordance with the judgement result by said first judging unit;

a firs detector for detecting a torsional angle in accordance with each position selected by said selector;

a first selector for selecting a pair which does not include a broken magnetic sensor from a pair consisting of said first magnetic sensor and said second magnetic sensor and a pair consisting of said third magnetic sensor and said fourth magnetic sensor when any one of said first to fourth magnetic sensor has been broken;

a second judging unit for judging whether or not said positions detected by said magnetic sensor of the pair selected by said first selector is included in a second range which is larger than said first range; and

a second detector for detecting the torsional angle in accordance with said position when said second judging unit has judged that the position is included in said second range; wherein

torque applied on said input shaft is detected in accordance with the torsional angle detected by said first or second detector.

7. A torque detecting device according to claim 6, wherein said second judging unit includes:

a second selector for selecting a pair which does not include a broken magnetic sensor from a pair consisting of said first magnetic sensor and said third magnetic sensor and a pair consisting of said second magnetic sensor and said fourth magnetic sensor;

a third judging unit for judging whether or not two positions detected by said magnetic sensors in a pair selected by said second selector are included in said first range;

a third selector for selecting one position from said two positions in accordance with a judgement result made by said judging unit; and

a corrector for correcting the position selected by said third selector in accordance with said two positions and said predetermined distance; wherein

whether or not said position of said targets is included in said second range is judged in accordance with the position corrected by said corrector.

8. A torque detecting device according to claim 6, wherein said targets is provided spirally on each circumferential surface of said input shaft and said output shaft.

9. A torque detecting device according to claim 6, wherein said targets are formed by protrusions made of magnetic material.

10. A torque detecting device according to claim 7, wherein said targets is provided spirally on each circumferential surface of said input shaft and said output shaft.

11. A torque detecting device according to claim 8, wherein a plurality of said targets are provided on the circumferential surface of each of said input shaft and said output shaft at the same intervals.

12. A torque detecting device according to claim 8, wherein said targets are formed by protrusions made of magnetic material.

13. A torque detecting device according to claim 9, wherein said targets are formed by protrusions made of magnetic material.

14. A steering apparatus, comprising:

an input shaft connected to a steering wheel;

an electric motor for assisting steering which is driven and controlled in accordance with the steering torque applied on said steering wheel;

an output shaft interlocked to said electric motor; and

a torque detecting device for detecting the steering torque applied on said input shaft in accordance with the torsional angle generated in said connecting shaft for connecting said input shaft and said output shaft, said torque detecting device comprising:

an input shaft and an output shaft each having targets disposed on the circumferential surface of said input shaft and said output shaft, said targets being made of magnetic material and inclined with respect to an axial direction of said input shaft and said output shaft;

a connecting shaft for connecting said input shaft and said output shaft;

first magnetic sensor and second magnetic sensor for detecting the positions where magnetic change occurs on the circumferential surfaces of said input shaft and said output shaft;

third magnetic sensor and fourth magnetic sensor for detecting the positions where magnetic change occurs in said axial direction which are distant from said positions detected by said first magnetic sensor and said second magnetic sensor for a predetermined distance in said circumferential direction and/or said axial direction;

a first judging unit for judging whether or not said positions detected by said first to fourth magnetic sensors are included in a first range ;

a selector for selecting the position for detecting

a torsional angle of said connecting shaft for each of said input shaft and said output shaft in accordance with the judgement result by said first judging unit;

a firs detector for detecting a torsional angle in accordance with each position selected by said selector;

a first selector for selecting a pair which does not include a broken magnetic sensor from a pair consisting of said first magnetic sensor and said second magnetic sensor and a pair consisting of said third magnetic sensor and said fourth magnetic sensor when any one of said first to fourth magnetic sensor has been broken;

a second judging unit for judging whether or not the positionsdetectedbysaidmagneticsensorofthepairselected by said first selector is included in a second range which is larger than said first range; and

a second detector for detecting the torsional angle in accordance with said position when said second judging unit has judged that said position is included in said second range; wherein

torque applied on said input shaft is detected in accordance with the torsional angle detected by said first or second detector.

15. A rotational angle detecting device, comprising: targetsdisposedinthecircumferentialdirectionofarotating

shaft such that said targets are inclined with respect to an axial direction of said rotating shaft;

magnetic sensors disposed opposite to the position where said targets are disposed to generate outputs which are changed when each target passes; and

an angle calculator for calculating the rotational angle of said rotating shaft in accordance with a result obtained by multiplying outputs of said magnetic sensor with a gain; wherein

said angle calculator includes a gain corrector for correcting said gain in accordance with a maximum value and a minimum value of outputs of said magnetic sensor when said plural targets pass.

16. A rotational angle detecting device according to claim 15, wherein said gain corrector obtains a ratio of the difference between the maximum value and the minimum value and a predetermined reference difference to obtain a corrective gain by multiplying a result with the reference gain set for said reference difference.

17. A rotational angle detecting device according to claim 15, wherein a plurality of said magnetic sensors are provided in the circumferential direction on the outside of said target such that the phases are shifted.

18. A rotational angle detecting device according to claim 16, wherein a plurality of said magnetic sensors are provided in

the

circumferential direction on the outside of said target such that the phases are shifted.

19. A rotational angle detecting device, comprising:

targetsdisposedinthecircumferentialdirectionofarotating shaft such that said targets are inclined with respect to an axial direction of said rotating shaft;

magnetic sensor disposed opposite to the position where said targets are disposed to generate outputs which are changed when each target passes; and

an angle calculator for calculating the rotational angle of said rotating shaft in accordance with a result obtained by multiplying outputs of said magnetic sensor with a gain, wherein

said angle calculator includes an offsetting unit for offsetting said output in accordance with a maximum value and a minimum value of outputs of said magnetic sensor when said plural targets pass.

20. A rotational angle detecting device according to claim 19, wherein said offsetting unit makes the difference between an average value of said maximum value and said minimum value and a predetermined reference average value to be an offset amount.

21. A torque detecting device, comprising:

two rotational angle detecting devices disposed apart from each other in the axial direction of said rotating shaft, said rotational angle detecting devises comprising:

targets disposed in the circumferential direction of a rotating shaft such that said targets are inclined with respect to an axial direction of said rotating shaft;

magnetic sensors disposed opposite to the position where said targets are disposed to generate outputs which are changed when each target passes; and

an angle calculator for calculating the rotational angle of said rotating shaft in accordance with a result obtained by multiplying outputs of said magnetic sensor with a gain, wherein

said angle calculator includes a gain corrector for correcting said gain in accordance with a maximum value and a minimum value of outputs of said magnetic sensor when said plural targets pass; and

a torque calculator for calculating the torque applied on saidrotatingshaftinaccordancewiththedifferenceintherotational angle detected by each rotational angle detecting device.

22. A rotational angle detecting device according to claim 21, wherein said gain corrector obtains a ratio of the difference between the maximum value and the minimum value and a predetermined reference difference to obtain a corrective gain by multiplying

a result with the reference gain set for said reference difference.

23. A torque detecting device, comprising:

two rotational angle detecting devices disposed apart from each other in the axial direction of said rotating shaft, said rotational angle detecting devises comprising:

targets disposed in the circumferential direction of a rotating shaft such that said targets are inclined with respect to an axial direction of said rotating shaft;

magnetic sensors disposed opposite to the position where said targets are disposed to generate outputs which are changed when each target passes; and

an angle calculator for calculating the rotational angle of said rotating shaft in accordance with a result obtained by multiplying outputs of said magnetic sensor with a gain, wherein

said angle calculator includes an offsetting unit for offsetting said output in accordance with a maximum value and a minimum value of outputs of said magnetic sensor when said plural targets pass; and

a torque calculator for calculating the torque applied on saidrotatingshaftinaccordancewiththedifferenceintherotational angle detected by each rotational angle detecting device.

24. A rotational angle detecting device according to claim

23, wherein said offsetting unit makes the difference between an average value of said maximum value and said minimum value and a predetermined reference average value to be an offset amount.

25. A torque detecting device, comprising:

two pairs of plural targets and two magnetic, wherein

said plural targets are disposed in the circumferential direction of a rotating shaft and inclined with respect to an axial direction of said rotating shaft; and

said two magnetic sensors are disposed opposite to each other at positions on the outside of said targets such that the phases of said magnetic sensors are shifted in the circumferential direction to generate outputs which are changed when each target passes;

are provide apart from each other in the axial direction of said rotating shaft, and the difference between outputs of either of selected magnetic sensor in each pair is used to calculate the rotational torque applied on said rotating shaft;

a comparator for comparing the absolute value of the difference in the output of the selected magnetic sensors and the difference in the output of the non-selected magnetic sensors;

a judging unit for judging the sign of the difference in the output between selected magnetic sensors and the sign of the difference in the output between non-selected magnetic sensors; and

a selector for selecting a magnetic sensor for use in calculating the rotational torque in accordance with a judgement result by said judging unit and a comparison result by said comparator.

26. A torque detecting device according to claim 25, wherein said selector changes selection of said magnetic sensor when the comparison by said comparator has resulted in a fact that the absolute value of the difference in the output of the selected magnetic sensors is larger than the absolute value of the difference in the output of the non-selected magnetic sensors by a predetermined quantity under condition that the judgement result by said judging unit are such that the selected magnetic sensors and the non-selected magnetic sensors are the same.

27. A torque detecting device, comprising:

two sets of plural targets and a magnetic sensor, wherein

said plural targets are disposed in the circumferential direction of a rotating shaft and inclined with respect to an axial direction of said rotating shaft; and

said magnetic sensors are disposed opposite to the position corresponding to said targets to generate output changed when each target passes;

are disposed apart from each other in the axial direction of said rotating shaft; and

a torque calculating unit for calculating the rotational

torque applied on said rotating shaft in accordance with the difference in the output of the magnetic sensors of two sets; wherein

said torque calculating unit obtains an average value of said two pairs of said magnetic sensors during passing of each of said plural targets to set a corrective gain with which each output is multiplied so as to make coincide the outputs of the two sets of said magnetic sensors with said average value.

28. A rotational angle detecting device, comprising a rotational member; a target provided on said rotational member; first detecting means disposed to face said target so as to output a detection signal according to a rotation of said rotational member; and second detecting means disposed to face said target so as to output a detection signal whose phase is different from the detection signal outputted by said first detecting means by a predetermined electrical angle; and for detecting a displacement angle in a direction of rotation of said rotational member based on the detection signals outputted by said first detecting means and said second detecting means, said rotational angle detecting device further comprising:

first judging means for judging whether each of the detection signal outputted by said first detecting means and the detection signal outputted by said second detecting means is greater or less than a substantially middle value between maximum and minimum values to be taken by said detection signals;

second judging means for judging a relation in magnitude

between the detection signal outputted by said first detecting means and the detection signal outputted by said second detecting means; and

third judging means for judging magnitudes of differences between each of said detection signals and said substantially middle value; wherein

the displacement angle in the direction of rotation of said rotational member is detected based on results of judgments by said first judging means, second judging means and third judging means.

29. The rotational angle detecting device as set forth in claim 28, wherein said targets are magnetized so that magnetic poles reverse at substantially equal intervals in a circumferential direction of said rotational member.

30. The rotational angle detecting device as set forth in claim 29, wherein a plurality of said targets are provided with a space therebetween in a circumferential direction of said rotational member.

31. The rotational angle detecting device as set forth in claim 30, wherein said targets are made of non-dent portions between dents formed at substantially equal intervals in the circumferential direction of said rotational member so as to form said non-dent

portions.

32. The rotational angle detecting device as set forth in claim 30, wherein said targets are made of protrusions arranged at substantially equally intervals in the circumferential direction of said rotational member.

33. A torque detecting device for detecting a torque applied to a first shaft, based on a torsional angle generated in a connecting shaft connecting coaxially said first shaft and a second shaft, comprising said rotational angle detecting devices of claim 32, attached to said first shaft and second shaft, respectively, wherein

a difference between displacement angles detected by said rotational angle detecting devices respectively is made to be the torsional angle.

34. A steering apparatus comprising:

a first shaft connected to a steering wheel;

a steering assist electric motor driven and controlled based on a steering torque applied to said steering wheel;

a second shaft interlocked with said electric motor; and

said torque detecting device of claim 33 for detecting a steering torque applied to said first shaft, based on a torsional angle generated in a connecting shaft connecting said first shaft and said second shaft.

35. A rotational angle detecting device comprising: detecting means for detecting a position of a target and outputting a detection signal according to the detected position; a rotational member on which said target is provided so that the detection signal changes according to a rotation; and angle calculating means for calculating a rotational angle of said rotational member based on the detection signal multiplied by a gain, said rotational angle detecting device further comprising:

means for detecting a maximum value and a minimum value of the detection signal multiplied by said gain;

means for calculating a difference between the detected maximum value and minimum value: and

gain correcting means for correcting said gain so that the calculated difference is equal to a preset reference difference.

36. The rotational angle detecting device as set forth in claim 35, further comprising:

means for calculating a ratio of said calculated difference to said reference difference; and

means for calculating a corrective gain by multiplying a preset reference gain by said calculated ratio; wherein

said gain correcting means corrects said gain to said corrective gain.

37. The rotational angle detecting device as set forth in claim 35, wherein said target is provided on said rotational member so that a distance between said target and said detecting means changes according to a rotation.

38. The rotational angle detecting device as set forth in claim 35, wherein said target is made of protrusions provided at substantially equal intervals in a circumferential direction of said rotational member.

39. The rotational angle detecting device as set forth in claim 35, wherein said target is made of non-dent portions between dents formed at substantially equal intervals in a circumferential direction of said rotational member so as to create the non-dent portions.

40. The rotational angle detecting device as set forth in claim 35, wherein said target is magnetized so that magnetic poles reverse at substantially equal intervals in a circumferential direction of said rotational member.

41. The rotational angle detecting device as set forth in claim 35, wherein said target comprises a first inclining portion provided to incline in one direction on a circumferential surface

of said rotational member, and a second inclining portion provided to incline in other direction on the circumferential surface of said rotational member.

42. The rotational angle detecting device as set forth in claim 35, wherein said detecting means comprises first detecting means and second detecting means, juxtaposed in a direction of rotation of said rotational member, for outputting detection signals having a phase difference.

43. The rotational angle detecting device as set forth in claim 42, further comprising:

first judging means for judging whether or not each of the detection signals of said first detecting means and second detecting means is higher than a first threshold greater than a detection signal value obtained when detection signal waveforms of said first detecting means and second detecting means crossed each other;

second judging means for judging whether or not each of the detection signals of said first detecting means and second detecting means is lower than a second threshold smaller than a detection signal value obtained when the detection signal waveforms of said first detecting means and second detecting means crossed each other; and

third judging means for judging whether or not the detection signal waveforms of said first detecting means and second detecting

means cross each other; wherein

the maximum value and minimum value of said detection signal are detected based on results of judgements made by said first, second and third judging means.

44. A torque detecting device, comprising:

said rotational angle detecting devices of claim 43, provided for each of a first rotating shaft and a second rotating shaft which are coaxially connected to each other; and

torque calculating means for calculating a torque applied to said first rotating shaft, based on a difference between rotational angles detected by said rotational angle detecting devices.

45. A torque detecting device, comprising:

said rotational angle detecting devices of claim 43, provided for each of a first rotating shaft and a second rotating shaft which are coaxially connected to each other; and

torque calculating means for calculating a torque applied to said first rotating shaft, based on a difference between rotational angles detected by said rotational angle detecting devices; wherein

when both the first detecting means and both the second detecting means of said rotational angle detecting devices detected the maximum values, the maximum values are made valid, while when both the first detecting means and both the second detecting means detected the minimum values, the minimum values are made valid.

46. The torque detecting device as set forth in claim 45, further comprising:

temperature detecting means for detecting temperature of said first detecting means and second detecting means;

storing means for storing a temperature detected by said temperature detecting means when the maximum value or the minimum value of each of the detection signals of said first detecting means and second detecting means was detected; and

means for calculating a difference between the temperature detected by said temperature detecting means and the temperature stored in said storing means and comparing the calculated difference with a predetermined value when said angle calculating means calculates a rotational angle; wherein

when the difference is greater than the predetermined value, the calculation of said angle calculating means is prohibited.

47. A steering apparatus, comprising:

a first rotating shaft connected to a steering wheel;

a second rotating shaft connected coaxially to said first rotating shaft and connected to a steering mechanism;

said torque detecting device of claim 46, for detecting a steering torque applied to said first rotating shaft; and

an electric motor for assisting a rotation of said second rotating shaft, based on the steering torque.

48. A rotational angle detecting device comprising: detecting means for detecting a position of a target and outputting a detection signal according to the detected position; a rotational member on which said target is provided so that the detection signal changes according to a rotation; and angle calculating means for calculating a rotational angle of said rotational member based on the detection signal multiplied by a gain, said rotational angle detecting device further comprising:

means for detecting a maximum value and a minimum value of said detection signal;

means for calculating an average value of the detected maximum value and minimum value: and

off set correcting means for correcting said detection signal so that the calculated average value is equal to a preset reference average value.

49. The rotational angle detecting device as set forth in claim 48, further comprising means for calculating a difference between said calculated average value and said reference average value, wherein

said offset correcting means adds said difference to said detection signal value so that the calculated difference becomes zero.

50. A rotational angle detecting device, comprising first detecting means and second detecting means, wherein

one or a plurality of targets are provided on a rotational member so that said first detecting means outputs a detection signal according to a rotation of said rotational member,

said second detecting means outputs a detection signal whose phase is different from the detection signal of said first detecting means, and

a rotational angle of said rotational member is detected based on the detection signals outputted by respective said first detecting means and said second detecting means.

51. The rotational angle detecting device as set forth in claim 50, further comprising:

judging means for judging a relation in magnitude between detection signals outputted by said first detecting means and said second detecting means respectively in a previous cycle of sampling and a relation in magnitude between detection signals outputted by said first detecting means and said second detecting means respectively in this cycle of sampling;

judging means for judging whether the detection signal outputted by said first detecting means or said second detecting means in this cycle of sampling is greater or less than a substantially middle value between maximum and minimum values to be taken by

said detection signals; and

judging means for judging whether or not each of the detection signals outputted by said first detecting means and said second detecting means in this cycle of sampling is within a predetermined range; whereby

a displacement angle in a direction of rotation of said rotational member is detected based on results of judgments by said respective judging means.

52. The rotational angle detecting device as set forth in claim 51, wherein said targets are made of protrusions provided at substantially equal intervals in a circumferential direction of said rotational member.

53. The rotational angle detecting device as set forth in claim 51, wherein said targets are made of non-dent portions between dents that are formed at substantially equal intervals in a circumferential direction of said rotational member so as to form said non-dent portions.

54. The rotational angle detecting device as set forth in claim 51, wherein said targets are magnetized so that magnetic poles reverse at substantially equal intervals in a circumferential direction of said rotational member.

55. The rotational angle detecting device as set forth in claim 51, wherein said target comprises a first inclining portion arranged to incline in one direction on a circumferential surface of said rotational member, and a second inclining portion arranged to incline in other direction on the circumferential surface of said rotational member, wherein said first inclining portion and said second inclining portion are magnetized.

56. The rotational angle detecting device as set forth in claim 51, wherein said first inclining portion and said second inclining portion are substantially line symmetrical about a straight line passing through a connected point between said first and second inclining portions in an axial direction of said rotational member.

57. The rotational angle detecting device as set forth in claim 51, further comprising:

selecting means for selecting either of said first detecting means and second detecting means and either of an increasing state and a decreasing state of a detection signal value to be outputted by said detecting means, based on results of judgments by said respective judging means, whereby

a displacement angle in a direction of rotation of said rotational member is detected based on the detecting means and the state of the detection signal value selected by said selecting

means in the previous cycle of sampling and the detection signals outputted by said selected detecting means in the previous cycle of sampling and this cycle of sampling, respectively.

58. A torque detecting device comprising said rotational angle detecting device of claim 57 for each of a first shaft and a second shaft which are connected by a connecting shaft, whereby

a torque applied to said first shaft is detected based on a difference between detection signals outputted by said first detecting means or said second detecting means of each of said rotational angle detecting devices due to torsion generated in said connecting shaft.

59. The torque detecting device as set forth in claim 58, further comprising:

sign judging means for judging a sign of each of the difference between the detection signals outputted by said first detecting means and the difference between the detection signals outputted by said second detecting means; and

first comparing means for comparing magnitudes of the detection signals outputted by said first detecting means and second detecting means on said first shaft side when said sign judging means judged that the signs of said differences were identical; whereby

a torque applied to said first shaft is detected based on

a result of comparison by said first comparing means.

60. The torque detecting device as set forth in claim 59, further comprising second comparing means for comparing magnitudes of a substantially middle value between maximum and minimum values to be taken by the detection signals and each of the detection signals outputted by said first detecting means and second detecting means on said first shaft side when said sign judging means judged that the signs of said differences were different, whereby

a torque applied to said first shaft is detected based on a result of comparison by said second comparing means.

61. The torque detecting device as set forth in claim 60, further comprising:

first judging means for judging whether or not at least one of the detection signals outputted by said first detecting means is out of a predetermined range;

second judging means for judging whether or not at least one of the detection signals outputted by said second detecting means is out of a predetermined range; and

third comparing means for comparing magnitudes of an absolute value of a difference between the detection signals outputted by said first detecting means and an absolute value of a difference between the detection signals outputted by said second detecting means; whereby

a torque applied to said first shaft is detected based on a result of comparison by said second comparing means, a result of judgment by said first judging means, a result of judgment by said second judging means, and a result of comparison by said third comparing means.

62. The torque detecting device as set forth in claim 61, further comprising:

abnormality detecting means for detecting abnormality of detection signals outputted by each of a pair of said first detecting means and a pair of said second detecting means; and

means, when an abnormality was detected in one of said detection signals by said abnormality detecting means, for making a difference between the detection signals outputted by the pair of detecting means including the detecting means which outputted an abnormal detection signal zero; whereby

when there is one abnormal detection signal, a torque applied to said first shaft is detected without using said one detection signal.

63. The torque detecting device as set forth in claim 62, further comprising:

storing means for storing the detection signals outputted by said first detecting means and said second detecting means and preset detection signals to be outputted according to each of the

detection signals outputted by said first detecting means and said second detecting means, in association with each other; and

means for outputting said detection signals to be outputted, based on the detection signals outputted by said first detecting means and said second detecting means and contents stored in each of said storing means, whereby

detection signals outputted by said means are made detection signals outputted by said first detecting means and said second detecting means, respectively.

64. A steering apparatus comprising:

a first shaft connected to a steering wheel;

a second shaft connected to a steering mechanism;

a connecting shaft connecting said first shaft and said second shaft; and

said torque detecting device of claim 63 for detecting a steering torque applied to said first shaft, based on a torsional angle generated in said connecting shaft; whereby

steering is assisted according to the steering torque detected by said torque detecting device.

65. A torque detecting device comprising: two sets of one or a plurality of targets provided on a rotational member and one or a plurality of detecting means, disposed at separate positions in a direction of a rotational shaft of said rotational member,

for outputting signals continuously according to a rotation of said rotational member; and a torque calculating unit for calculating a rotational torque applied to said rotational member, based on the signals outputted by said detecting means respectively, wherein

said torque calculating unit comprises correcting means for calculating an average value of the signals outputted by said detecting means while said targets are passing positions facing said detecting means and for correcting said signals outputted by said detecting means to coincide with the average value.

66. A steering apparatus comprising:

a first shaft connected to a steering wheel;

a second shaft connected to a steering mechanism;

a torsion bar which connects said first shaft and said second shaft;

said torque detecting device of claim 65, for detecting a steering torque applied to said first shaft, based on a torsional angle generated in said torsion bar; and

a motor driven and controlled based on the steering torque detected by said torque detecting device, for assisting rotation of said second shaft.

67. The torque detecting device as set forth in claim 65, wherein said rotational member rotates according to a first shaft and a second shaft that are coaxially connected through a torsion

bar, and is provided on each of said first shaft and second shaft at positions adjacent to the connection thereof.

68. The torque detecting device as set forth in claim 67, wherein said targets are made of protrusions provided at substantially equal intervals in a circumferential direction of said rotational member.

69. The torque detecting device as set forth in claim 67, wherein said targets are made of non-dent portions between dents formed at substantially equal intervals in a circumferential direction of said rotational member so as to form said non-dent portions.

70. The torque detecting device as set forth in claim 67, wherein said targets are magnetized so that magnetic poles reverse at substantially equal intervals in a circumferential direction of said rotational member.

71. The torque detecting device as set forth in claim 67, wherein said target comprises: a first inclining portion arranged to incline in one direction on a circumferential surface of said rotational member; and a second inclining portion arranged to incline in other direction on the circumferential surface of said

rotational member, wherein said first inclining portion and said second inclining portion are magnetized.

72. The torque detecting device as set forth in claim 67, wherein said first inclining portion and said second inclining portion are substantially line symmetrical about a straight line passing a connected point between said first and second inclining portions in an axial direction of said rotational member.